

cell fates during animal development.

The significance of the molecular and functional characterization of *hairy* and *groucho* genes in *P. pacificus* comes from interpretation in the context of other species. Specifically, sequence analysis shows that a gene that can encode a Hairy-related protein capable of interacting with Groucho is absent from the *C. elegans* genome, whereas this type of gene is present in the genome of many other animals, including *P. pacificus*, *Drosophila* and humans. The implication is that the hairy-related gene was lost in the lineage leading to *C. elegans*, which among nematodes exhibits the ancestral anterior border pattern in the vulval equivalence group. In contrast, the ancestral genetic module is retained in *P. pacificus*, yet it participates in establishing the derived trait and restricting the cells that participate in the vulval equivalence group.

How is it that the 'old' Hairy-Groucho module does 'new' tricks? The answer will likely reflect the modular nature of transcriptional regulatory regions which allows them to play a significant role in evolutionary change. For example, co-option of a conserved transcription factor module to a new regulatory role might occur if sequence changes introduced the appropriate DNA binding site into the regulatory

region of a target gene [2]. The common ancestor of *C. elegans* and *P. pacificus* is predicted to have exhibited both the ancestral trait (a larger vulval equivalence group) and molecular features (the Hairy-Groucho module). Separate evolutionary changes resulting in the loss or alteration of the *hairy* gene from the lineage leading to *C. elegans*, and recruitment of the Hairy-Groucho module to participate in restriction of the vulval equivalence group, could produce the results described by Schlager *et al.* [3]. Thus the presence of the Hairy-Groucho module *P. pacificus* is ancestral, whereas the process in which it has been recruited to participate is derived.

This new work shows how the basic evolutionary themes of co-option of existing genes to new functions and loss or change of genes can contribute to the evolution of traits and coincidentally underlie genomic change. Questions for the future include whether the nematode species differences also reflect changes in additional genes, and what are the specific molecular alterations responsible for the new Hairy-Groucho module function in *P. pacificus*. Evolution is limited to acting on existing genetic resources, but it is becoming apparent that the potential toolkit is large, and over time multiple changes can accumulate and assort in new and exciting combinations.

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Conservation Biology: Beyond Marine Protected Areas

Socioeconomic and ecological analyses of eleven coral reef conservation efforts make clear that marine protected areas are not the answer, and that in fact support of local communities is far more important than some government mandated 'fishing closure'. Apparently there are marine 'paper parks' just as there are terrestrial 'paper parks'.

Peter Kareiva

At the annual meeting of the American Association for the Advancement of Science (AAAS) in 1997, Jane Lubchenco called for

protecting 20% of the surface area of the world's ocean as no-fishing zones by 2020 (<http://www.pbs.org/newshour/science/coralreefs/agreements.html>). This plea for 'marine protected areas'

was more slogan than science ("20% in 2020"), although there is no ignoring data indicating that many of the world's fisheries have been overexploited and that our marine ecosystems are in trouble because of poor management [1]. We have now had almost ten years of symposia, books, working groups, debates, implementation and lawsuits relating to marine protected areas. Marine protected areas are slowly being established around the world, but no one would yet call the push for marine protected areas a resounding success.



Figure 1. Fishers collectively harvesting from a customary tambu area at Ahus Island, Manus, Papua New Guinea. Photo credit: Michael Marnane.

The problem is not with the idea of protecting fish from harvest. No one doubts that marine protected areas, if enforced, generally will yield more fish and larger fish inside the protected areas. The controversy surrounds what happens to the total fish catch outside of marine protected areas, and more importantly what marine protected areas mean to those who depend on fisheries for their living. In theory, marine protected areas could allow a build up of fish populations that then spilled over into unprotected areas, and thus were harvested. This spillover outcome from marine protected areas would thus accomplish what harvest quotas and restrictions so often fail to do — provide for a sustainable fishery.

Unfortunately evidence in support of the spillover benefits of marine protected areas and especially of economic benefits to fishermen is lacking [2]. This does not mean that marine protected areas do not work, but rather that properly designed experiments for evaluating their impacts are lacking. The absence of compelling evaluations of effectiveness is not peculiar to marine protected areas; in general, conservation science does a terrible job when it comes to critical examination of its dearest ideas and asking whether its

projects deliver on their promises [3]. Sometimes it seems that ‘good intentions’ are enough to excuse conservation from serious self-scrutiny. Yet conservation scientists can do better and are, in fact, starting to do better. Resistance to marine protected areas by recreational and commercial fisheries communities requires that we do the best we can with the data on hand and make a serious effort to evaluate the impacts of marine protected areas on the livelihood of fishing communities.

As they report in this issue of *Current Biology*, Tim McClanahan of the Wildlife Conservation Society and colleagues [4] have just completed the most compelling multi-site comparison of different approaches to marine conservation, including marine protected areas, yet to be conducted. They contrast three different marine conservation approaches, two of which represent a form of marine protected area. The two marine protected area approaches are either traditional ‘top-down’ government established National Parks, or ‘bottom-up’ co-management agreements in which local communities and non-governmental organisations enforce no-fishing zones. The alternative to marine protected

areas took the form of community-based fishery management without permanent protected areas, but with a wide variety of temporary restrictions on fishing effort. The analysis by McClanahan’s team [4] was applied only to coral reefs and thus benefited from having a common ecosystem as a baseline. These studies took place in Indonesia and Papua New Guinea (Figure 1), areas that have suffered from overfishing and destructive blast fishing, and that are noted for tremendous biodiversity as well as economically valuable fisheries.

Other conservation scientists have attempted to draw generalizations by comparing management approaches as reported by different research teams and using different methods [5]. But this [4] is the first time that different management approaches applied to several different coral reefs have been examined by a standardized and common approach. Within each management area or its paired matched control site, fish were sampled along transects and data were analyzed so that fish biomass was effectively a measure of catch per unit effort. Nonetheless, the comparisons between coral reefs made by McClanahan and colleagues [4] are apples and oranges. The standard National Park protected areas were large (6,600–111,625 hectares), whereas the community-managed areas were small (33–58 hectares), and the co-managed protected areas were also small (12–60 hectares). Keeping in mind the confounding effect of size, however, the results are astonishing. The measure selected to quantify effectiveness was the percent increase in total biomass for targeted fish inside the managed area compared to outside the management area. This increase never exceeded 10% for the large National Park protected areas, and was typically dismally low (averaging less than 2% over four different National Parks). Small co-managed marine protected areas did much better — averaging over a 15% increase in fish biomass for a collection of four of these

'bottom-up' marine protected areas. The small community management areas without any permanent protection or harvest closures did best by far — averaging over a 40% increase in the targeted fish biomass as compared to outside the management zone. Clearly there are problems with these analyses. The contrasts are inside versus outside management areas after the management areas were established. To be rigorous, one really needs data comparing inside versus outside, before and after the management areas were established. Secondly, even if there is more fish biomass inside the management areas, that does not speak to benefits flowing to the fishery community.

In spite of its limitations, the McClanahan *et al.* [4] study is compelling because it draws our attention to the most important aspect of marine conservation — the social context. In addition to collecting biological data on targeted fish, the researchers also collected socioeconomic data on the stakeholders and local communities interacting with the marine protected areas or management zones. The National Park marine protected areas tended to have low compliance, were not in sight of any village, and had well over 80% of the harvested fish sold to market. In contrast, the community-based management areas without marine protected areas were all in sight of local villages and averaged only 35% of

the fish being sold to market (the rest being used by the fishermen's households and families). Using all eleven fishery management areas and categorizing each management effort in terms of socioeconomic attributes produced a clear picture of the factors that lead to effectiveness. Higher visibility of reserves to local communities and higher compliance were associated with higher overall increases in fish biomass. There are no surprises there. On the other hand, larger human populations, a greater percentage of fish sold to market, a greater percentage of households involved in salaried employment, and greater local wealth made it less likely that the management areas would be effective. If one wanted to develop a narrative about these indicators, it seems that the best managers of fisheries are the poorer communities that depend upon fish for their own food source, compared to wealthier communities that exploit fisheries for economic gains and may not reside in close proximity to the managed areas.

McClanahan and colleagues [4] make vivid that marine protected areas are not the silver bullet solution for every situation and for every community. The fact that fish populations inside the large National Parks show no benefits is disturbing — at a minimum one would hope that a marine protected area could actually produce an effect within its

boundaries. The absence of any detectable benefit to the large National Park marine protected areas appears to be yet another example of the 'paper park' phenomenon [6]. One cannot achieve conservation that is at odds with the people. Fortunately, there are alternatives that can work much better when they have local community support. Far more important than modeling the ideal design of marine protected areas or networks of marine protected areas is building local social and community support for them. This is a lesson that has sometimes escaped the most ardent academic promoters of the marine protected area conservation strategy.

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Cell Polarity: Formin on the Move

Formins assemble actin filaments that are typically arranged in long bundles. A new study has discovered that a fission yeast polarity formin transiently assembles short actin filaments at the cell tip, and then releases from the cortex and rides into the cell interior on filaments within the bundle.

David R. Kovar

Formins are large multi-domain proteins that assemble actin filaments for basic cellular processes such as division, adhesion, motility and establishing

polarity [1–3]. A growing list of actin organization properties have been ascribed to formins (Figure 1). Nevertheless, the specific mechanisms by which formins assemble actin-dependent structures in cells are largely

unclear. By imaging the fission yeast actin cable formin For3p fused to three copies of the green fluorescent protein (For3p–3xGFP) in live cells, Martin and Chang [4] have gone a long way towards elucidating the details of actin cable assembly. They found that For3p–3xGFP transiently associates with the cell cortex and then moves inward with the elongating actin cable. Therefore For3p may initiate actin filament assembly for only a few seconds at the cell tip before being inactivated. Inactive For3p is then